The Canadian Entomologist

LXXXIII Ottawa, Canada, April, 1951 No. 4

Species of *Eupithecia* Reared in the Forest Insect Survey in British Columbia (Lepidoptera: Geometridae)[1]

By MARGARET R. MACKAY[2]

Forest Insect Investigations, Division of Forest Biology
Ottawa, Canada

Introduction

The majority of specimens on which the following descriptions are based were collected as larvae and reared to maturity in British Columbia in the Forest Insect Survey, Forest Insect Investigations. Though this procedure has certain definite advantages, it presents some difficulties in description, the adults often being darker in colour and smaller in size than those captured in flight. It was also observed that the structures of the genitalia are sometimes more delicate in reared specimens, so that single adults were, at times, difficult to associate with the descriptions and with genitalia mounts in the Canadian National Collection. Five new species, a new subspecies, and the previously unknown female of a sixth species are described in this paper. Brief notes on the biology, the distribution, and host plants of some previously recorded species have also been included.

The districts of British Columbia to which reference is made throughout the paper may be located in the *Geographical Gazeteer of British Columbia, 1930.*

Eupithecia transcanadata n. sp.

Plate I: Figs. 1, 2, 3, 4. Plate IV: Figs. 1, 2

Though slightly smaller, very closely related to *E. palpata* Packard. Ground colour of adults deep golden brown ("avellaneous" of Ridgway's (1912) colour chart), an unevenness of pigmentation resulting in a mottled appearance. Terminal and subterminal areas of primaries usually dark and separated by a faint, pale s.t. line, which is crenulate and terminates in a small, pale spot above the tornus; a double pale line (formed by two parallel dark lines, together with inner edge of subterminal area) in postmedial area of many specimens, showing a blunt outward angulation at vein 6 and a faint inner one at vein 2; the dark line forming inner border of double pale line always present and distinct, usually rounded rather than bluntly angled at vein 6 and usually slightly crenulate; discal spot inconspicuous; t.a. line angled outward just basad of discal spot and then inwardly oblique; entire median space on occasion a dark band crossing the primary. Palpi porrect and blade-like, projected beyond front for a distance often about one and one-half times length of head from vertex to anterior edge of front. Male antennae feebly bifasciculate; ciliae shorter than width of antenna, and arising in groups from small tubercules; fasciculate nature obscured by numerous secondary ciliae. A whitish patch of scales present in median area of mesothoracic scutellum; remainder of thorax dark in colour. Abdomen as dark as thorax dorsally, with some continuation of the white scaling along the median line, black scaled laterally, prominently whitish ventrally.

Male genitalia.—Ninth segment without hair-pencils. Tegumen, uncus, vinculum, and valve as in *palpata.* Aedoeagus moderately stout, often slightly narrowed in the middle; apical section distinctly striate. Vesica with two curved, somewhat twisted bars of sclerotin joined distally by a sclerotized band, the more

[1]Contribution No. 2760, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

[2]Agricultural Research Officer.

slender piece narrowing rather abruptly to a crooked point, so that it together with the more heavily sclerotized portion of the other gives the appearance of extending less than one-third of the entire aedoeagus; also a small, inconspicuous piece of sclerotin near the distal end of the larger bar in most specimens. Ventral plate of eighth segment consisting of rods similar to those of *palpata* but usually slightly more slender, incurved distally, and hook-like at apices.

Female genitalia.—Tergum of eighth segment with its apophyses, ostium, ductus bursae, and cervix bursae as in *palpata.* Ductus seminalis membranous, broad, arising dorsally a little to the right near distal end of cervix, bending cephalad for a short distance, then narrowing sharply to a fine, thread-like tube. Bursa small, usually globular, its surface entirely covered with moderately large spines, which graduate in size from the largest near the cervix, just below the beginning of the ductus seminalis, to smaller but distinct spines on the left side of the bursa.

Holotype, male.—Fernie, Kootenay district, B.C.; Forest Insect Survey No. BC49-2417B; No. 5913 in the Canadian National Collection, Ottawa.

Allotype, female.—Fernie, Kootenay district, B.C.; F.I.S. No. BC49-2418.

Paratypes.—Kootenay district, B.C.:—Trout Lake: 1 ♂, BC49-1891D; Golden: 1 ♂, BC49-1717C, 1 ♀, BC49-2022; Lardeau: 1 ♂, BC49-1589D; Fernie: 1 ♂, BC49-2420C; Kaslo: 1 ♀, BC48-2258; Incomappleux River: 1 ♀, BC49-1895.

Kamloops district, B.C.:—Dixon Creek: 1 ♂, BC49-2241; Shuswap Lake: 1 ♂, BC49-1456B; Celista: 1 ♂, BC47-910B; Dunn Lake: 1 ♀, BC49-2340; Hupel: 3 ♀ ♀, BC49-1141F, BC49-1233D, BC49-2794B; Enderby: 2 ♀ ♀, BC48-3519C, BC49-1240D.

Osoyoos district, B.C.:—Echo Lake: 1 ♂, BC49-1542E.

Lillooet district, B.C.:—Lac La Hache: 1 ♀, BC49-1958.

Cariboo district, B.C.:—Lost Lake: 1 ♂, BC49-2989C; 1 ♀, BC49-2989C.

Coast district, B.C.:—Kitimat River: 1 ♀, BC48-2832B.

Types and paratypes have been deposited in the Canadian National Collection, Ottawa.

The larvae are found in late July and August. Pupation occurs in September. The larvae are very similar to those of *palpata,* but were noted by W. C. McGuffin (1942) to be usually darker in colour.

Distribution.—This species is known to occur in the interior and coastal areas of British Columbia and in Alberta, Ontario, Quebec, and Nova Scotia. Its distribution probably corresponds with that of its hosts.

Hosts.—Douglas fir, hemlock, spruce, and balsam; occasionally cedar, larch, and pine.

E. transcanadata was included with *palpata* in the revision of North American species of *Eupithecia* by J. McDunnough (1949), and in the Canadian National Collection. In most instances, however, specimens of the two species may be easily distinguished. The ground colour of *palpata* is also a golden brown but is suffused with dark grey, particularly in reared adults; short blackish streaks on either side of the s.t. line result in a slightly striated appearance in the terminal section of the wing; specimens lack the mottled effect and variation of wing pattern apparent in a series of *transcanadata* individuals; the double light line in the postmedial area, almost always present and distinct, is slightly more sharply angled at vein 6, is usually crenulate, and lacks the conspicuous, dark inner border so noticeable in *transcanadata.* The male antennae are bifasciculate; although the fasciculate nature may in some specimens be somewhat obscured by secondary ciliae, it is more obvious than in *transcanadata.*

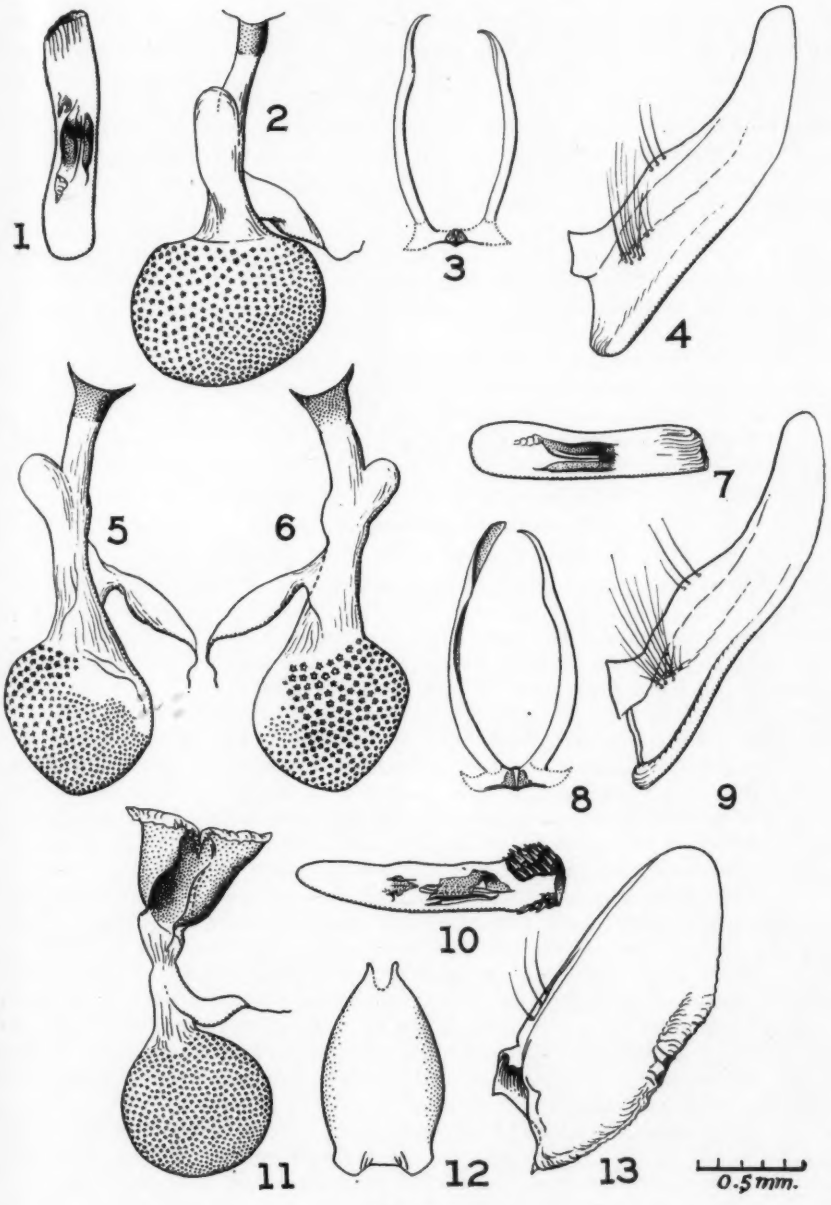

PLATE I

Figs. 1-4. *Eupithecia transcanadata* n. sp. (paratypes). 1, aedoeagus; 2, bursa, ventral view; 3, ventral plate of male; 4, right valve.

Figs. 5-9. *E. palpata* Packard (holotype male and allotype female). 5, bursa, ventral view; 6, bursa, dorsal view; 7, aedoeagus; 8, ventral plate of male; 9, right valve.

Figs. 10-13. *E. harrisonata* n. sp. (holotype male and allotype female). 10, aedoeagus; 11, bursa, dorsal view; 12, ventral plate of male; 13, right valve.

The male genitalia may be separated by means of the armature of the vesica. In *palpata* the two curved bars are more nearly straight; the more slender piece tapers in a curve to a point and it, together with the sclerotized portion of the other, gives the appearance of extending about one-third, sometimes more, of the length of the aedoeagus, and not less than one-third as in *transcanadata*. The additional small area of sclerotin has not been observed in *palpata*.

There is considerable difficulty in distinguishing the species by the female genitalia, particularly when the bursa is poorly inflated. However, in *palpata* the bursa varies from almost globular to moccasin-shaped; and there is considerable gradation in the size of the spines: those near the cervix, just below the beginning of the ductus seminalis, being large and distinct; those on the left side of the bursa becoming very small, and disappearing altogether in an area of varying size near the cervix.

Known hosts of *palpata* are lodgepole pine and white pine in the West, jack pine and white pine in the East. Occasional specimens have been found on Douglas fir, hemlock, red pine, and larch.

Remarks.—Specimens of the two species were compared with the type specimen, a male lacking the abdomen, in the Museum of Comparative Zoology, Cambridge, Mass., to ascertain which was *palpata* Packard.

Eupithecia pseudotsugata n. sp.

Plate II: Figs. 1, 2, 3, 4, 5. Plate IV: Figs. 5, 6

Wing expanse of type series, which is composed entirely of reared specimens, 17 mm. to 23 mm., males averaging 19-20 mm., females slightly more. Maculation heavily suffused with smoky grey, the heaviest suffusion on the primaries occurring in the terminal and subterminal areas. Ground colour light drab or light greyish olive, dark areas blackish grey (Ridgway, 1912). S.t. line pale, faint, crenulate where apparent, and forming a small pale spot above tornus; a slightly striated appearance effected on either side of s.t. line by short dark lines; a distinct double light line formed by three dark lines in postmedial area broadest near costa, outwardly angled at vein 6, faintly inwardly angled at vein 2, and narrowed toward the inner margin; double light line often edged in subcostal and costal regions by a heavier suffusion of dark scales, making this species more easily recognized; median space crossed by a dark line touching discal spot or just basad of it; t.a. line dark, angled outwardly below costa with varying degrees of sharpness, then obliquely inward. Male antennae clearly bifasciculate; ciliae slightly shorter than width of antenna, and arising in groups from small tubercules. Palpi long, blade-like, and porrect, projecting forward usually for a greater distance than length from vertex to anterior margin of head; palpi dark-scaled, contrasting with pale front. Thorax dark, except for white scales on mesothoracic scutellum. Abdomen dark dorsally with a continuation of the white scaling along the median line of the first two or three segments, pale ventrally, and streaked laterally with black.

Male genitalia.—Typical of the *palpata* group. Aedoeagus slender, the apical section faintly striate. Vesica with the usual two curved bars of sclerotin joined distally by a sclerotized band, and a third long but poorly defined apical piece. Rods of the ventral plate of eighth segment stout, only slightly bowed, but incurved and strongly hooked in their apical fourth or fifth.

Female genitalia.—Dorsal plate of eighth segment rectangular, lightly sclerotized. Ostium about same width as ductus bursae; ductus bursae finely spiculate near ostium, comparatively short, narrow, entering cervix dorsally, slightly from the right and just below the apex. Cervix bursae broad, lightly striated, with slight sclerotization in some specimens at the distal end of ductus seminalis. Ductus

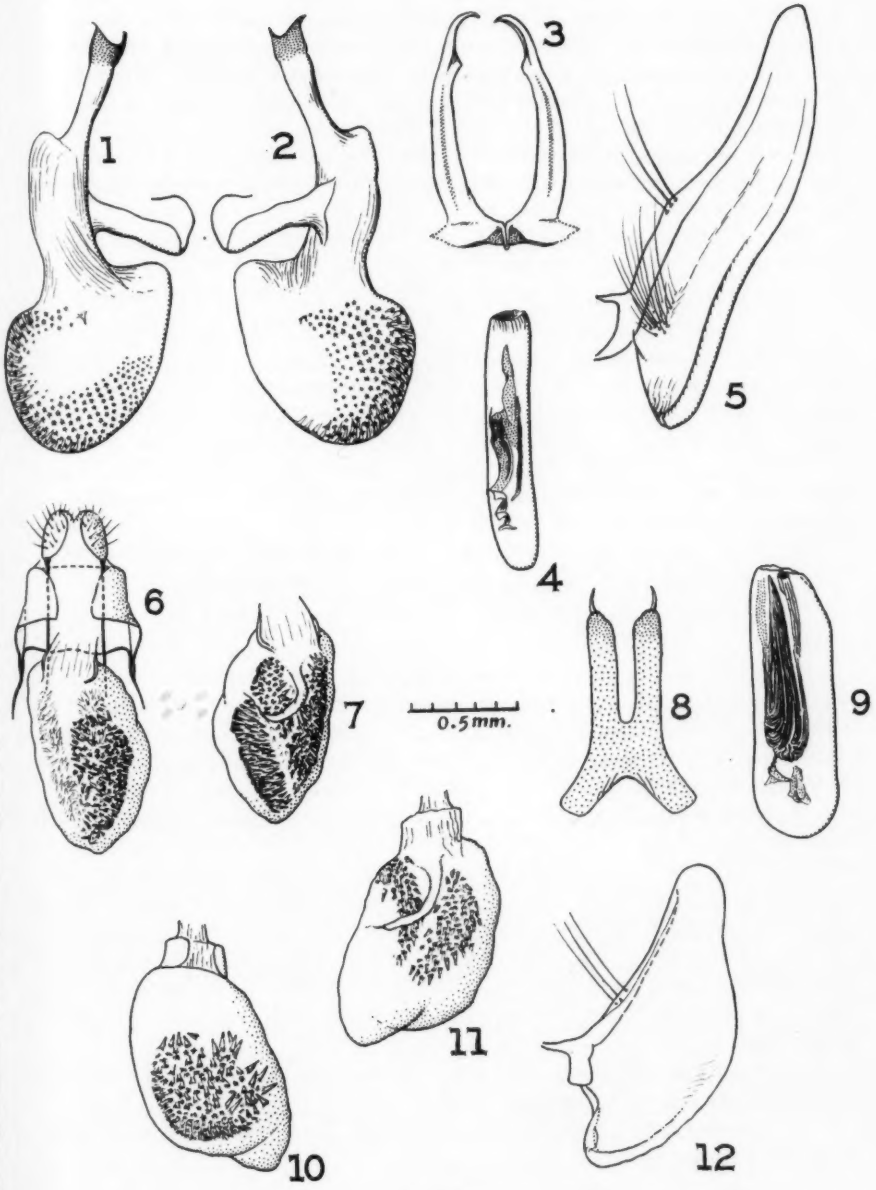

PLATE II

Figs. 1-5. *E. pseudotsugata* n. sp. (holotype female and allotype male). 1, bursa, ventral view; 2, bursa, dorsal view; 3, ventral plate of male; 4, aedoeagus; 5, right valve.

Figs. 6-7. *E. usurpata* Pearsall (allotype). 6, female genitalia, ventral view; 7, bursa, dorsal view.

Figs. 8-12. *E. vinsullata* n. sp. (holotype male and allotype female). 8, ventral plate of male; 9, aedoeagus; 10, bursa, ventral view; 11, bursa, dorsal view; 12, right valve.

seminalis emerging dorsally, a little to the right in the mid-section of the cervix, extending cephalad for a short distance, then narrowing sharply to the usual fine tube. Bursa variable, sometimes broadly shoe-shaped like that of *sabulosata* McDunnough, but usually more compact and more nearly globular, with, however, a blunt heel always to the right; spined section also variable, but generally consisting of a broad band on the left side, which extends onto the fundus area and onto the central area of the dorsal surface, the remainder of the bursa being membranous.

Holotype, female.—Otter Lake, Kamloops district, B.C.: Forest Insect Survey No. BC49-2066C; No. 5914 in the C.N.C., Ottawa.

Allotype, male.—Parson, Kootenay district, B.C.: F.I.S. No. BC49-2094B.

Paratypes.—Kootenay district, B.C.:—Athalmer: 1 ♂, BC49-1667D; Gray Creek: 2 ♂ ♂, BC49-2663C, BC49-2699B, 1 ♀, BC49-2735C; Kokanee Park: 1 ♂, BC49-2737D; Halcyon: 1 ♂, BC49-2974C; Skookumchuck: 1 ♂, BC49-1510A; Canal Flats: 3 ♂ ♂, all BC49-1546A; 2 ♀ ♀, BC49-1503B, BC49-1551; Parson: 1 ♀, BC49-2080B; Creston: 1 ♀, BC49-2785A; Rampart: 1 ♀, BC49-2565A.

Similkameen district, B.C.:—Hedley: 3 ♂ ♂, BC47-1908C, BC47-1908C, BC47-959H, 1 ♀, BC47-1908B; Skagit River: 1 ♂, BC47-963D; Bridesville: 1 ♂, BC49-3018A; Oliver: 1 ♀, BC49-2961A.

Osoyoos district, B.C.:—Vernon: 3 ♂ ♂, BC48-4021, BC48-4032A, BC48-3973A, 1 ♀, BC48-3148A; Okanagan Landing: 1 ♂, BC47-1680B.

Yale district, B.C.:—Princeton: 1 ♀, BC47-974C; Laird Lake: 1 ♀, BC49-2933C.

Kamloops district, B.C.:—Lac La Jeune: 1 ♂, BC47-1814B; Heywood Corner, 1 ♂, BC49-1782E; Little Fort: 1 ♀, BC46-493C; Celista: 1 ♀, BC48-1841C; Mahood Lake: 1 ♀, BC49-1925B.

Lillooet district, B.C.:—Jesmond: 1 ♀, BC49-1517D; Lillooet: 2 ♀ ♀, BC49-1826B, BC49-1837C.

Types and paratypes have been deposited in the Canadian National Collection, Ottawa.

There may be two colour phases of the larvae, green and reddish-brown: but most of the type series were green or yellow-green, with a distinct reddish dorsal stripe indistinctly edged by lighter green lines, and with no ventral line, or with the ventral line light. According to Forest Insect Survey notes, they are somewhat similar to the larvae of *ornata* (Hulst), which occurs on pine. They are found in late July, August, and early September. Hibernation occurs in the pupal stage.

Hosts.—Of the 39 larvae from which adults were reared, 38 were collected on Douglas fir and one on spruce.

Distribution.—This species is known to occur in the interior of British Columbia and in Alberta.

Remarks.—The genitalia of *pseudotsugata* place it near *placidata* Taylor and *sabulosata* McD. However, the female differs noticeably from that of *placidata* in the entrance of the ductus into the cervix bursae, from *sabulosata* usually in the spining and shape of the bursa itself, and from both species in the lack of sclerotization of the cervix; in the male the ventral plate of the eighth segment and the extra piece of sclerotin in the apical section of the vesica separate it, the latter being absent in *placidata*.

***Eupithecia harrisonata* n. sp.**

Plate I: Figs. 10, 11, 12, 13. Plate IV: Figs. 7, 8

A species closely related to *luteata bifasciata* Dyar, for which it might easily be mistaken, but considerably larger, with a wing expanse averaging 19 or 20 mm. in reared specimens; and with a more clearly defined maculation, the latter being partly due to the absence of the luteous coloration between veins 2 and 4 of the primaries that breaks the t.p. line and the dark subterminal band in *luteata*. Ground colour light buff ("tilleul-buff" of Ridgway's colour chart), often with a pale pinkish-buff area between veins 2 and 4; dark areas dark olive. Terminal and subterminal areas of the primaries dark; s.t. line pale, crenulate, and easily discerned; t.p. line pale, edged inwardly by a narrow dark band, tending to form a small outward angle on the subcostal vein, angled sharply outward on vein 6 and gently inward at vein 2; a striated appearance that is lacking in *luteata*, apparent, particularly just basad of the t.p. line, as a result of dark scaling on the veins; discal spot more commonly a streak than a dot, and, as in *luteata*, a light line crossing the medial space just beyond it, curving sharply outward about the dot, and again more softly just above the anal vein; t.a. line pale and usually distinct, forming acute outward angles basad of the discal dot and in the area of the submedial fold. Male antennae feebly trifasciculate; individual ciliae longer than those of *luteata*. Palpus moderately long, with the second joint upturned and the third joint porrect, the dorsal scales forming at the end of the second joint a slight tuft which is a continuation of the scale tuft on the anterior margin of the flat, sloping front. A white transverse line frequently present on the mesothorax, and the scutellum prominently whitish. (These characteristics of the palpi and the white scaling are also found in *luteata*). Abdomen dark dorsally and pale ventrally, with distinct blackish scaling laterally.

Male genitalia.—Similar to those of *luteata* with the exception of the aedoeagus, which is strongly spined at the apex rather than feebly spiculate; and of the vesica, which lacks the single, small, pointed spine of the latter species.

Female genitalia.—Like those of *luteata* with one characteristic difference: the sclerotized ductus bursae, which is much broader than the cervix and is often almost as large as the bursa itself, tapering from its greatest width at the ostium to the cervix; on the ventral surface a central depression, approximately of the same breadth as the cervix, extending the entire length of ductus.

Holotype, male.—Harrison Lake, New Westminster district, B.C.; F.I.S. No. BC47-989E; No. 5915 in the C.N.C., Ottawa.

Allotype, female.—Woodfibre, New Westminster district, B.C.; F.I.S. No. BC48-4249.

Paratypes.—New Westminster district, B.C.:—Alta Lake: 2 ♂ ♂, both F.I.S. No. BC47-1961; Woodfibre: 1 ♂, BC48-4224B, 2 ♀ ♀, BC47-2126A, BC48-4246; McNair Creek: 1 ♂, BC47-1551E; Howe Sound: 1 ♂, BC47-2121D; Port Mellon: 1 ♂, BC48-4167B; Coquitlam Lake: 1 ♂, BC47-1818D; N. Howe Sound: 1 ♀, BC47-2120B; Gibsons Landing: 1 ♀, BC48-4234.

Yale district, B.C.:—Hope: 1 ♂, BC48-3376A, 1 ♀, BC48-2406.

Vancouver Island:—Buttle Lake: 1 ♂, BC48-2335C; Cottonwood Creek: 1 ♂, BC47-1819A; Courtenay: 1 ♂, BC48-2826A.

Types and paratypes have been deposited in the Canadian National Collection, Ottawa.

Late-instar larvae are typical of the genus *Eupithecia*, and vary from bright- to yellowish-green with darker dorsal and ventral lines. According to Forest Insect Survey records, there may be a reddish colour phase. The larvae are

found in late July, August and September. Pupation occurs in September and October. Hibernation is passed in the pupal stage.

Hosts.—The usual host is hemlock. Occasional specimens have been reared on larch, Douglas fir, balsam, and lodgepole pine.

Distribution.—This species is known at present only from the coastal areas of the mainland of British Columbia and from Vancouver Island.

***Eupithecia columbiata holbergata* n. subsp.**

Plate IV: Figs. 9, 10

Genitalia similar to those of *columbiata*, but in appearance adults difficult to associate with the much smaller and less colourful *columbiata columbiata* (Dyar) and *columbiata erpata* Pearsall. Adults rich in colour, with crisply marked primaries. Wing expanse 19 to 20 mm. Ground colour of primaries reddish-brown ("cinnamon" of Ridgway's colour chart), suffused with a deep, dark brown, especially in the terminal and subterminal areas; reddish-brown particularly apparent between veins 2 and 4, along vein 6 beyond the angle of the t.p. line, and in the costal region, sometimes extending basally on the cubital and anal veins; terminal area slightly striated; s.t. line whitish, crenulate, and distinct, forming a white spot above the tornus; oblique cross lines dark, similar to those of *columbiata*, the t.p. line being angled outwardly on vein 6 and faintly inwardly on vein 2. Palpi long and blade-like, typical of the *palpata* group. Male antennae not fasciculate; ciliae rather sparse, shorter than the width of the antenna, and arranged more or less in transverse rows, not arising from definite, raised warts. Abdomen distinguished by rich, dark-brown scales forming a transverse band dorsally on the second segment, the band being accentuated by pale shading on the preceding segment; abdomen also with considerable dark scaling laterally and toward tip; venter much darker than the undersurfaces of the wings.

Holotype, male.—Holberg Inlet, Vancouver Island, B.C.; F.I.S. No. P49-1446; No. 5916 in the C.N.C., Ottawa.

Allotype, female.—Henderson Lake, Vancouver Island, B.C.; F.I.S. No. BC48-1697.

Paratypes.—Vancouver Island, B.C.:—Nitinat River: 1 ♂, P49-2220A; Thetis Lake: 1 ♂, P49-1041E; Holden Lake: 1 ♂, P49-1271B; Jordan River: 1 ♀, BC48-1439A; Alberni: 2 ♀ ♀, BC48-1669B, BC48-2973; Campbell Lake: 1 ♀, BC48-1192B. Coast district, B.C.:—Rivers Inlet: 1 ♀, BC48-1931.

Types and paratypes have been deposited in the Canadian National Collection, Ottawa.

Larvae were collected in late June and early July. Pupation occurred in July. Hibernation was passed in the pupal stage.

Hosts.—Alder appears to be the most common host. Specimens have been collected and reared on willow, cascara, balsam, and Douglas fir.

Distribution.—This species is known from Vancouver Island and the coastal area of the mainland of British Columbia.

***Eupithecia columbiata columbiata* (Dyar)**

Specimens have been collected in the interior of British Columbia. Larvae were found during June and July. Alder, willow, birch, and maple have been recorded as food plants by officers of the Forest Insect Survey at Vernon.

***Eupithecia vinsullata* n. sp.**

Plate II: Figs. 8, 9, 10, 11, 12. Plate IV: Figs. 11, 12

A species characteristic of the *filmata* group. Specimens large, with a wing expanse of 20 to 27 mm. (bred specimens), and light grey in colour with slight brownish tinges apparent (near "smoke gray" of Ridgway's colour chart). Maculation of primaries like that of *annulata* (Hulst) but more suffused; tendency

of t.p. line to form a small but distinct inward angle on vein 7 as in *annulata*, and discal streak slightly elongate. Palpi porrect, projecting beyond the front a distance about equal to the depth of the eye, slightly longer in females. Male antennae distinctly bifasciculate; ciliations, as in *annulata*, about as long as twice the width of the antenna, and moderately sparse.

Male genitalia.—Valve broader in basal area and shorter than valve in either *annulata* or *filmata* Pearsall; ventral margin curved outward to midway between base and apex, then tapered to a blunt apex. Structures within vesica almost identical to those of *filmata*; a similar long, apically pointed, semi-cylindrical piece occupying two-thirds of the length of the aedoeagus, broadening toward the base and showing semicircular striations in that area. No appreciable difference observed in the depth of the fissure between the two terminal rods of the ventral plate, or in any other male structure.

Female genitalia.—Spining of bursa apparently like that of *annulata*, and no differences found by which the female genitalia of the two species might be separated.

Holotype, male.—Vinsulla, Kamloops district, B.C.; F.I.S. No. BC49-74K; No. 5917 in the C.N.C., Ottawa.

Allotype, female.—Savona, Kamloops district, B.C.; F.I.S. No. BC49-161B.

Paratypes.—Kamloops district, B.C.:—Carquile: 1 ♂, BC49-822D; Pritchard: 1 ♂, BC49-194B; Merritt: 1 ♂, BC49-550G.

Kootenay district, B.C.:—Cranbrook: 1 ♂, BC49-834; Kimberley: 1 ♂, BC49-1507A; Athalmer: 1 ♂, BC49-598C; Toby Creek: 1 ♂, BC49-532, 1 ♀, BC49-516C; Invermere: 1 ♀, BC48-865A; Windermere: 2 ♀ ♀, BC49-588A, BC49-636A; Wilmer: 2 ♀ ♀, both BC49-535A.

Cariboo district, B.C.:—Soda Creek: 1 ♀, BC49-347.

Lillooet district, B.C.:—Pavilion: 1 ♂, BC49-765F.

Three paratypes have been deposited in the reference collection of the Forest Insect Survey at Vernon, B.C., and the remainder of the type series are in the Canadian National Collection, Ottawa.

The adults emerge very early in the spring at the same time as *filmata* and *annulata*. The larvae are found in June. Pupation occurs in July.

Hosts.—Douglas fir.

Distribution.—This species is known only from the interior of British Columbia. It may occur in Alberta.

Remarks.—Three small, pale specimens from the interior of British Columbia resemble *filmata* in colour pattern and size, but are of a light-grey colour. The genitalia of the two males place them in *vinsullata*. The variability of maculation in *annulata* causes difficulty at times in the separation of females of that species and of *vinsullata*.

Eupithecia usurpata Pearsall

Plate II: Figs. 6, 7. Plate IV: Figs. 13, 14

Positive identity of the female and a clearer conception of the appearance of the adults of this species have been obtained from eight specimens collected in the Forest Insect Survey. Reared specimens are similar to those of *filmata* in size, averaging 19 and 20 mm. in wingspread. Compared with specimens of *olivacea* Taylor, they are a deeper, duller brown with considerable less distinctness of maculation; what may prove to be a good means of separating them from small adults of that species is the crenate rather than dentate s.t. line. Other characteristics, such as the reduced size of the discal dots, the shorter pectinations of the male antennae and the deep fissure between the terminal rods of the male

ventral plate agree perfectly with Pearsall's observations as enumerated by McDunnough (1949).

In the female genitalia, the bursa resembles closely that of *olivacea* with one distinguishing difference: the dorsal spining extends narrowly to the fundus area. Also, the ovipositor lobes appear to be shorter in comparison with their width than those of *olivacea*, but this requires further checking. Little variation was observed in the shape, which is more nearly oval than globular, or in the spining of the bursae of the six females studied.

Allotype, female.—Merville, Comox district, Vancouver Island; F.I.S. No. P49-554B; No. 5919 in the C.N.C., Ottawa.

Paratypes.—Nanoose district, B.C.:—Parksville: 1 ♀, P49-861C. Vancouver Island, B.C.:—Thetis Lake: 1 ♀, P49-1036A. Thetis Island:—1 ♀, P49-66A.

Allotype and paratypes have been deposited in the Canadian National Collection, Ottawa.

Of the eight specimens received, all but one were collected and reared on balsam or on grand fir; one, from Thetis Island, was apparently found on alder.

Eupithecia olivacea Taylor

The food plant of a single specimen from Quadra Island is recorded as balsam fir.

Summary of the *filmata* group

Since a species, *vinsullata*, has been added, and the female of *usurpata* discovered, it may be to the advantage of those attempting to identify individuals of this group to summarize briefly those characteristics of each species at present known.

E. filmata Pearsall.—Adults of medium size with distinct maculation, at times difficult to distinguish from small specimens of *annulata*; male ventral plate with deep fissure; large, pointed piece of sclerotin in vesica broader and longer than that of *annulata*, spining on dorsal surface of bursa extended *broadly* to fundus; outward bulge of membrane of bursa above fundus area. Host generally spruce. Known to occur in eastern United States and across Canada in so-called spruce belt.

E. annulata (Hulst).—Adults variable in size, colour, and intensity of maculation but usually large and contrastingly marked, more nearly brown than grey. Male ventral plate with deep fissure; large, pointed piece of sclerotin in vesica more slender and shorter than that of *filmata*; bursa extremely variable, at times almost globular with dorsal and ventral spining similar to that of *olivacea*, at times more nearly oval with dorsal spining extending to fundus area as in *usurpata*, but commonly with a pronounced outward bulge above the fundus area serving to separate it from either species. Hosts variable: hemlock, balsam fir, and spruce, but more often Douglas fir. Apparently occurring in a range similar to that of *filmata*, but seldom collected in the East. Difficulty in identifying female specimens that tend toward the grey colouring of *vinsullata*.

E. vinsullata MacKay.—Adults large, grey; maculation similar to that of *annulata* but more suffused. Male ventral plate with deep fissure; large, pointed piece of sclerotin in vesica identical to that of *filmata*; valve broader at base and shorter than that of *annulata* or *filmata*. Bursa apparently similar to that of *annulata*. Host Douglas fir. Known only from interior of British Columbia but possibly extending into Alberta.

E. usurpata Pearsall.—Adults of medium size, dull brown, with obscure maculation; male antennae with short ciliae. Male genitalia, including the ventral plate, similar to those of *annulata*. Bursa more nearly oval, not globular; spining narrowly extended to fundus area. Hosts commonly balsam fir and grand fir. Known only from Vancouver Island and coastal districts of B.C. A small, poorly

marked female of *annulata* perhaps difficult to distinguish from one of *usurpata*.

E. olivacea Taylor.—Adults large, of uniform, brownish maculation, which is obscure but not to such a degree as in *usurpata*, which is duller brown. Male ventral plate with short fissure; male genitalia otherwise apparently similar to

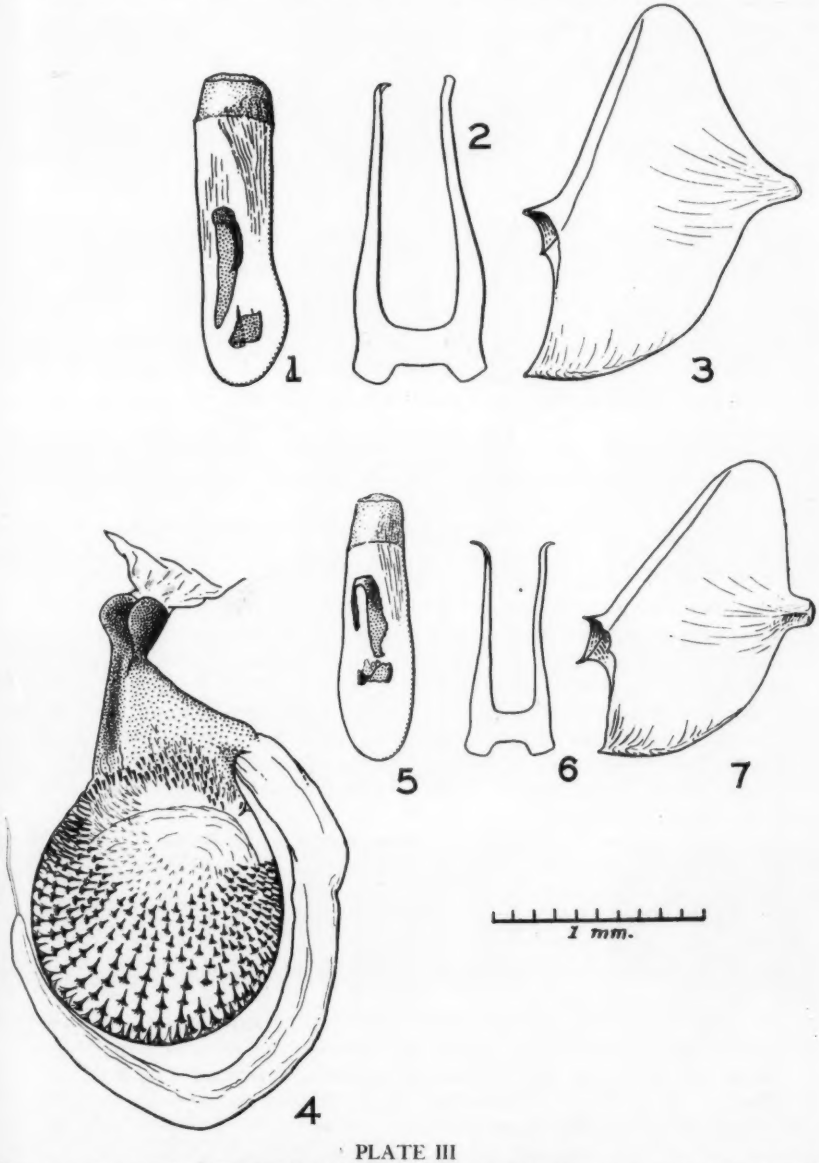

PLATE III

Figs. 1-3. *E. georgii* McDunnough (holotype male). 1, aedoeagus; 2, ventral plate of male; 3, right valve.

Figs. 4-7. *E. kananaskata* n. sp. (holotype male and allotype female). 4, bursa, ventral view; 5, aedoeagus; 6, ventral plate of male; 7, right valve.

those of *annulata*. Bursa globular or more or less oval, with usually no sign of an outward bulge above fundus; dorsal spining less extended toward fundus than in *usurpata*; ovipositor lobes possibly longer in comparison with their width than in *usurpata*. Host doubtful. Occurring on Vancouver Island; also collected from interior of British Columbia and from Oregon.

Eupithecia kananaskata n. sp.

Plate III: Figs. 4, 5, 6, 7. Plate IV: Fig. 15

In the Forest Insect Survey material were discovered two dark smoky-grey specimens of the male sex which, although distinct, are very closely related to *georgii* McDunnough. A third individual, almost denuded, from the Canadian National Collection matches them in genitalia. Also in the C.N.C. are two females, a very light brown in colour, whose maculation agrees perfectly with that of the reared males, and a third female, again badly scuffed, but whose genitalia agree with those of the other two. It is probable that the dark scaling of the two males has been intensified by rearing, and that the pale scaling of the others is the result of fading over a period of years, so that the normal colour of individuals caught in flight is somewhere in between.

Maculation more obscure than in *georgii*; s.t. line pale, decidedly less crenulate than that of *georgii*, particularly toward the costal area; t.p. line likewise; the short, dark dashes on the veins, and the brownish scaling at the forks of veins 3 and 4, characteristic of *georgii*, also present; the dentate, pale line crossing the secondaries much obscured and difficult to observe. Palpi short, as in *georgii*, extending only a little beyond the flat front; ciliae of male antennae short, less than the width of a segment, and fairly dense.

Male genitalia.—Hair-pencils present on ninth segment. Tegumen, uncus, and vinculum similar to those of *georgii*. Valve very broad in basal half, narrowed apically; on the ventral margin, just beyond the middle, a strong, broad, apically truncate projection which curves ventrally and has a well-developed ridge running lengthwise on its ventral surface. Aedoeagus moderately broad, possibly broader in comparison with its length than that of *georgii*, very slightly tapered and finely spiculate in apical section. Armature of vesica consisting of a small, twisted end piece and a large sclerotized piece; the latter actually a transverse, semicylindrical bar with two lateral processes, the shorter of which extends more than half the length of the other, the entire piece taking up about one-third of the length of the aedoeagus. The ventral plate of the eighth segment resembling that of *georgii*.

Female genitalia.—Nothing definite found to separate the female genitalia of *kananaskata* and *georgii* except that the bursa of the former appeared to be slightly less densely spined.

Holotype, male.—Kananaskis, Alberta; F.I.S. No. A254I; No. 5918 in the C.N.C., Ottawa.

Allotype, female.—Kaslo, Kootenay district, B.C., Coll. J. W. Cockle, Slide label *Eup.* 58m.

Paratypes.—Chilliwack, New Westminster district, B.C.: 1 ♂, BC48-4044C. Waterton Lakes, Alberta: 1 ♀, Coll. J. McDunnough, Slide label *Eup.* 40.

Type specimens are in the Canadian National Collection, Ottawa.

Hosts.—According to Forest Insect Survey labels, the two reared specimens were collected from willow and alder.

Eupithecia georgii McDunnough

The male genitalia of *georgii* differ from those of *kananaskata* in that the projection on the valve is bluntly pointed to a varying degree rather than apically truncate and lacks the ventral ridge; and the shorter lateral process of the sclero-

tized piece in the vesica is about half as long as the other, the entire structure taking up considerably more than one-third of the length of the aedoeagus.

Two specimens, apparently typical of *georgii*, from the Kamloops district, B.C., were obtained in the larval stage on birch and cedar.

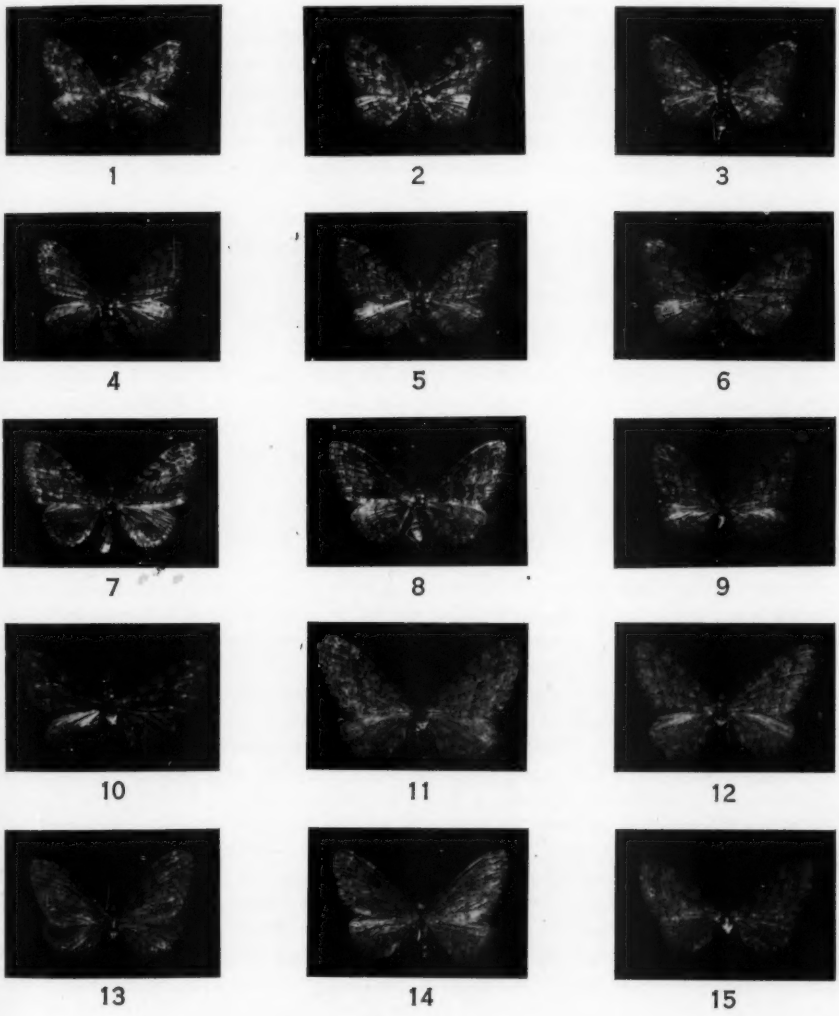

PLATE IV

Figs. 1, 2. *E. transcanadata* n. sp., females.
Figs. 3, 4. *E. palpata* Packard, male and female.
Figs. 5, 6. *E. pseudotsugata* n. sp., males.
Figs. 7, 8. *E. harrisonata* n. sp., females.
Figs. 9, 10. *E. columbiata holbergata* n. subsp., male and female paratypes.
Figs. 11, 12. *E. vinsullata* n. sp., male and female paratypes.
Figs. 13, 14. *E. usurpata* Pearsall, male, female paratype.
Fig. 15. *E. kananaskata* n. sp., male paratype.

Notes on Known Species

Eupithecia longipalpata Packard.—The larva of this species is long and slender, yellowish-green, with a narrow, yellowish, spiracular line extending onto the anal plate, and a narrow, dark dorsal line; the anal forks are readily visible. The larvae are among the first to appear in the field during the spring. There may be two generations annually; of a series of 45 adults, six were reared during the winter from larvae collected in the autumn. The others emerged from May to August, the heaviest emergence occurring in June and July.

Localities: Coastal districts of the mainland, Vancouver Island, Queen Charlotte Islands, and the following smaller islands along the coast: Saturna, Salt Spring, Quadra, Hornby, Galiano, Kuper, Mayne, Read, Denman, and Pender.

Hosts: Usually western hemlock and Douglas fir, but spruce, cedar, grand fir, and pine also recorded.

Eupithecia unicolor (Hulst).—The larvae of *unicolor* resemble cedar twigs in colour and pattern. They occur in April, May, and June. Adults emerge in July and August.

Localities: New Westminster district, Vancouver Island, Salt Spring, and Pender Islands. No records from the interior of British Columbia.

Hosts: Western red cedar; sometimes hemlock.

Eupithecia placidata Taylor.—Like those of *unicolor*, the larvae of *placidata* resemble cedar twigs. They are found late in the summer. Hibernation takes place in the pupal stage.

Localities: The Kootenay and Kamloops districts of the interior of British Columbia.

Host: Western red cedar.

Eupithecia ornata (Hulst).—*E. ornata* has not been recorded previously as far north as British Columbia. The larvae are striking in appearance, bright green in colour with a broad, red, dorsal stripe, which is edged by narrow, yellowish-green lines; the anal prolegs are reddish in colour, and the conspicuous anal forks are tipped with red. Larvae usually occur in July, and pupate in August. Hibernation takes place in the pupal stage.

Localities: Kootenay and Similkameen districts of the interior, the coast of British Columbia, and Vancouver Island.

Hosts: Lodgepole, white, and yellow pines; one specimen from larch.

Eupithecia luteata bifasciata (Dyar).—In addition to Douglas fir, western hemlock, and Englemann spruce, as listed by McDunnough (1949), grand fir and balsam are recorded as hosts, in localities on the British Columbia coast and on Vancouver Island.

Eupithecia castigata (Hubner).—Two specimens, one from Upper Pitt River and the other from Buntzen Lake, on the coast of British Columbia, have host labels "alder"; a third, from Mile 20 on the Alaska Highway, is recorded from poplar. The species has also been taken on spruce, balsam, and tamarack.

Eupithecia rotundopuncta Packard.—A specimen collected on spruce in the larval stage in the autumn emerged in the laboratory as an adult in May of the following year; its locality is Beattie Anchorage, Queen Charlotte Islands. Another specimen was collected on willow, at Prince Rupert.

Eupithecia albicapitata Packard.—Two specimens were collected as larvae on Engelmann spruce, at Salmon Arm and Sweetbridge, in the Kamloops district.

Eupithecia gibsonata Taylor.—The collection of two larvae from western red cedar at Minette Bay and near Terrace, in the coastal district of British Columbia, confirms the suspected occurrence of the species in the western portion of the continent.

Eupithecia gelidata Moeschler.—A single larva was collected on willow at Mile 184 on the Alaska Highway.

Eupithecia bryanti Taylor.—One specimen from Saturna Island and several from Waterton Lakes, Alberta, all collected from willow, verify McDunnough's (1949) supposition that willow is one of the hosts. The adults emerged in June and July.

Eupithecia anticaria Walker.—Two specimens from Kananaskis, Alberta, were reared from Indian paint brush and gaillardia.

Eupithecia nimbicolor (Hulst).—The host plants of four adults received from Kananaskis, Alberta, were recorded as rose, gooseberry, willow, and yarrow.

Eupithecia sheppardata McDunnough.—A single female of this species reared on alder was obtained from Cold Lake, Alberta. The species has not previously been recorded west of Biscotasing, Ontario.

Eupithecia graefii vancouverata (Taylor).—One specimen from Genoa Bay has red cedar as its recorded host, but a series of ten specimens from other localities on Vancouver and Gabriola islands was collected from and reared on arbutus, which appears to be the usual host.

Eupithecia fletcherata Taylor.—A single male from Dashwood on Vancouver Island seems to be identical with typical specimens in the Canadian National Collection from the eastern portion of the continent. The host is recorded as "alder". The species was previously recorded as feeding on conifers.

Eupithecia maestosa harlequinaria (Dyar).—Alder and arbutus are the recorded hosts of two specimens from Vancouver Island.

Eupithecia misturata.—An adult, in poor condition, was reared from a larva collected on alder at Tetachuck Falls, on the coast. A specimen of *misturata misturata* (Hulst) was found feeding on cascara at Saanich, V.I.

Acknowledgments

The assistance and advice of Dr. E. Munroe, Systematic Entomology, Division of Entomology, Ottawa, are gratefully acknowledged; and sincere thanks are extended to Mr. B. A. Sugden, Forest Insect Laboratory, Vernon, B.C., for help in the preparation of the slide mounts.

References

McDunnough, J. H. 1949. Revision of the North American species of the genus *Eupithecia* (Lepidoptera, Geometridae). *Bull. American Mus. Nat. Hist.* 93 (8).

McGuffin, W. C. 1942. New descriptions of larvae of forest insects. V, *Eupithecia*, *Hydriomena* (Lepidoptera, Geometridae). *Canadian Ent.* 74: 150-153.

Ridgway, R. 1912. Color standards and color nomenclature. Published by author. Washington, D.C.

Department of Lands, Province of British Columbia. 1930. Geographical gazetteer of British Columbia. Victoria, B.C.

Relationship Between the Entomological Society of Canada and Regional Entomological Societies in Canada

As many Canadian entomologists are still not clear about the relationship between the recently formed Entomological Society of Canada and the regional entomological societies in Canada, I shall attempt to clarify it.

The national society will serve not as the parent of but simply as the link between the Acadian Entomological Society, the Entomological Society of Quebec, the Entomological Society of Ontario, the Entomological Society of Manitoba, the Entomological Society of British Columbia, and any others that may be established.

Each regional society will be autonomous, with authority to set up its own constitution and by-laws and its own membership and annual dues, and to publish,

if so desired, its own annual report (e.g., annual reports of the Entomological Society of Ontario, the Entomological Society of Manitoba, and the Entomological Society of British Columbia). The national organization will promote the welfare of the regional entomological societies and will encourage the formation of others. It will do nothing that might conceivably weaken them and in no sense will it dominate them.

Some confusion still exists about the fees for membership in the national society. For entomologists in an area not served by a regional society, the membership fee for 1951 is $4.00, and this is payable to Mr. A. B. Baird, Science Service Building, Carling Avenue, Ottawa. For entomologists who are members of regional societies, the membership fee in the Entomological Society of Canada is $3.00, payable to the secretary-treasurer of one of the local societies. It follows, therefore, that most of the dues will be collected by the regional societies.

The Entomological Society of Canada and the Entomological Society of Ontario have the responsibilities of publishing *The Canadian Entomologist* regularly, of maintaining high standards in it, and of keeping it solvent, but they cannot carry these responsibilities without the whole-hearted support and co-operation of the regional societies. Each regional society must therefore exert every effort to enlist practically 100 per cent of its members in the Entomological Society of Canada and to provide the editor of the journal with papers of high quality. The future status of the Entomological Society of Canada and of *The Canadian Entomologist* will be determined very largely by the amount of support afforded them by all entomologists in this country.

W. A. Ross,
President, Entomological Society of Canada.

Obituary Notice

It is with deep regret that we have to report the death of Dr. Sievert Allen Rohwer of the United States Bureau of Entomology and Plant Quarantine. He collapsed and died in his office on February 12, 1951. He was 62 years of age at the time of his death.

Dr. Rohwer was a world authority on hymenoptera and was the author of numerous scientific articles and monographs on the insects of that order. In 1931, he was appointed Assistant Chief of the Bureau of Entomology and Plant Quarantine and served in that capacity until December 1950. At that time, he was made co-ordinator of the studies of biological warfare against livestock and crops.

He was born at Telluride, Colorado, and was educated at the University of Colorado. In 1948, that university conferred on him an honorary degree of Doctor of Science. Dr. Rohwer was past president of the American Association of Economic Entomologists, the Biological Society of Washington, D.C. and the Entomological Society of Washington. He was past vice-president of the Washington Academy of Sciences and member of the Entomological Society of America.

Dr. Rohwer was an outstanding scientist, an indefatigable worker and an able administrator. His death is an irreparable loss to the United States Department of Agriculture but his influence will be felt for many years to come. The entomologists of Canada will gratefully remember him for his helpful co-operation in the solution of scientific and international problems and for his fine qualities as a friend. They wish to express their deep sympathy to their colleagues in the United States and to the bereaved family of the deceased.

J. J. de Gryse

The Role of the Ant in the Biological Control of Homopterous Insects[1]

By STANLEY E. FLANDERS[2]
Division of Biological Control, University of California
Citrus Experiment Station, Riverside

The ant as a factor in "facultative helotism"[3] plays an important role in the biological control of certain agricultural pests. This phenomenon was noted by Linnè in 1758 (Jones 1929; Wheeler 1910), when he observed that honeydew-producing insects such as aphids, mealybugs, and scale insects often functioned as "cows of the ants."

The importance of this function in the biological control of homopterous insects lies in the fact that certain species are effectively controlled by their natural enemies when ants are absent, but not when ants are present. The ant, in gathering the honeydew supplied by such homopterous insects, tends more or less automatically to protect them from their natural enemies (Huber 1810). This apparently protective effect is not limited to the honeydew-producing species but is often extended to other phytophagous forms such as the citrus red mite, *Paratetranychus citri* (McGregor), (Kenyon 1935; DeBach, Fleschner, and Dietrick 1951) and diaspid scale insects (Flanders 1945) when such forms happen to be within the area of ant activity.

As pointed out by Wheeler (1910), the gregarious and rather sedentary habits of the plant-feeding Homoptera (Aphididae, Coccidae, Membracidae, Fulgoridae, and Psyllidae) enable the ants "to obtain a large amount of food without losing time and energy in ranging far afield from their nests." They may, in fact, move their nests to the "cow"-bearing plants (vaccaries) that they visit regularly. The extent of this helotic relation is determined by the needs of the ant population. Since ant populations are usually highly localized, their influence on biological control is likewise localized.

The ants of most economic importance in helotism are the "nectar-seeking" species in the subfamilies Camponotinae, Dolichoderinae, and Myrmicinae (Wheeler 1910; Bequaert 1922). The effect of such ants on biological control is dependent on (1) the extent to which fruit trees and other agricultural plants are subject to infestation by ant-attended pests, (2) the extent to which such pests are subject to control by ant-affected natural enemies, and (3) the distribution and density of the ant populations.

An ant-attended pest population, if large, is very destructive; if small and localized, however, it may serve as a nucleus of a food supply for the natural enemies, enabling the latter to maintain the pest population in general at a lower level than would be likely in the absence of ants.

In foreign explorations for entomophagous insects to use against homopterous pests, the presence of ants is advantageous in that they often lead the collector to a vaccary and a colony of Homoptera that otherwise might escape detection. Such an ant-protected colony also provides a means of readily obtaining natural enemies: By eliminating the ants from the vaccary and then allowing time for the natural enemies to find the unprotected colony, a supply of parasites for shipment may be obtained much sooner than would be the case otherwise (Compere 1940). In the colonization of such natural enemies for establishment it is obvious that the presence of ants is highly disadvantageous (Flanders 1940).

[1]Paper No. 660, University of California Citrus Experiment Station, Riverside, California.
[2]Entomologist in the California Agricultural Experiment Station.
[3]*Helotism*: any symbiotic relation of organisms in which one symbiont acts as the slave of the other, as that of alga to fungus in lichens (obligatory helotism) and the trophic service rendered to ants by coccids (facultative helotism).

Heavy localized infestations of certain homopterous insects, particularly of soft (brown) scale and of citrus mealybugs, usually occur in the presence of ants. When the ants are eliminated, the infestations are usually destroyed by natural enemies (Woglum 1919, 1942). This effect of ant control has been observed so often that it is convincing evidence that the generally low non-economic density of these pests is the result of biological control. The conclusions of Borden (1923), Smith (1917), and Woglum (1942), that the citrus mealybug and soft (brown) scale are under control by natural enemies, appear to be based entirely on this form of bioassay.

The species of natural enemy that ultimately destroys an ant-created population of a pest may or may not be the species generally responsible for the control of the pest. For example, in southern California, the chalcid *Metaphycus stanleyi* Comp. may destroy an ant-created population of *Coccus hesperidum* L., although the effective species usually is *M. luteolus* (Timb.).

The artificial use of ants for the bioassay of biological control by establishing ant populations, as successfully demonstrated by DeBach, Fleschner, and Dietrick (1951) with red scale, is of course limited and, with homopterous species that at times cause serious damage in the absence of ants, is of questionable value. For such a bioassay to be applicable, the pest must be under control by effective natural enemies *that are handicapped by ant activity*. In each case the possibility that the ants cause an increase in the pest population in other ways should be considered.

It is well known that in the gathering of honeydew ants render a "sanitary" service as well as a "protective" service to the homopterous insects involved (Heim 1898; Newell and Barber 1913; Woglum 1919; Horton 1918; Huber 1920; Borden 1923; Barber 1923; and Herzig 1937). Continuous removal of the honeydew decreases the mortality of the young stages of the pest by eliminating the chance of their being engulfed in accumulated deposits of it (Flanders 1942), and increases the rate of development of the pest so that it attains a greater size and fecundity.

According to Van der Goot (1916), the helotic relation of *Plagiolepis longipes* to *Coccus viridis* causes an acceleration of excretion by the scale, an extension of the feeding period, and an increased developmental rate. Ant-attended individuals attain maturity in 65 days, whereas those unattended require 83 days. Newell and Barber (1913) found that in the absence of natural enemies cultures of the sugarcane mealybug, *Pseudococcus boninsis*, became larger and healthier when ant-attended than when free of ants. In 1888, observations by Boz (Wheeler 1910) showed that aphids, when attended by ants, extracted more plant juices than when unattended. Phillips (1934) points out that plant-feeding Homoptera are stimulated by ants in such a way as to increase greatly their normal demands on plant tissues. Woglum (1942) states that black scale, *Saissetia oleae*, is frequently thrown into an off-hatch condition by ants.

An ant colony removes a large amount of honeydew. A single worker of *Formica exsectoides*, for example, when replete, carries 3 mg. of honeydew. Certain ant-attended homopterous insects tend to excrete honeydew in small amounts, frequently, with little expenditure of energy. In the absence of ants the honeydew is excreted in larger amounts, less frequently, and so forcibly in some species as to carry it a distance of more than 6 inches (Andrews 1930).

It should be noted that the honeydew produced by the various homopterous species is not uniformly attractive to ants. That produced by citricola scale, *Coccus pseudomagnoliarum* (Kuw.), is much less attractive than that produced by either *C. hesperidum* L. or *C. viridis* (Green). Certain species of the genus

Aphis are more attractive to ants than most other species of Aphididae (Jones 1929). Ants attending aphid species that produce a highly desired form of honeydew may mutilate or clip the aphids wings and thus prevent the flight of the aphids when the colony is suddenly disturbed. Such mutilation was observed by Tissot (1939) on *Cinara newelli* and by R. C. Dickson (unpublished notes) on *Microsiphum artemisiae* (Gillette).

Many natural enemies are not subject to interference by ants (Smith 1942; Flanders 1943). The activities of parasites such as *Coccophagus capensis* Comp., parasitic on black scale, are not so inhibited. In fact, ant attendance on the host species creates conditions favorable for the reproduction of such parasites by inhibiting the work of the more effective enemy species. The writer has observed heavy infestations of black scale that were swarming with ants and yet were completely parasitized by *C. capensis*. Of the species that suffer from ant interference, those that feed, as adults, on the body tissues of the host insects suffer most. Many predators and a few endoparasitic Hymenoptera, such as the black scale parasite *Metaphycus helvolus* (Flanders 1950), are in this category. Natural enemies that do not feed, as adults, on the host tissues suffer interference in proportion to the time required to deposit their eggs in the host's body. To this category belong many dipterous and hymenopterous parasites. The black scale parasite *Coccophagus trifasciatus* Comp., which oviposits rapidly, often works effectively after populations of scales protected by the Argentine ant become sufficiently dense. Hyperparasites are more likely to suffer from ant interference than primary parasites, since the former, as a rule, require more time to deposit an egg.

Prior to 1927 the only satisfactory method for controlling the citrophilus mealybug, *Pseudococcus gahani* Green, was by the mass production and colonization of the predator *Cryptolaemus montrouzieri* Muls. The Argentine ant, *Iridomyrmex humilis* Mayr, interfered with the work of this predator by destroying the adults and by causing them to fly from the infested areas where they were needed (Smith and Armitage 1931). Subsequent to the introduction and establishment in California of the remarkably efficient parasites *Tetracnemus pretiosus* Timb. and *Coccophagus gurneyi* Comp., species which are *not affected by ant activity*, the ant lost its influence on the populations of the citrophilus mealybug.

The effect of helotism on populations of homopterous insects is extremely variable, being dependent on the density and activity of the ant populations, on the physiological response of the homopterous insect to ant attendance, and on the feeding and ovipositing habits of the natural enemies (Flanders 1943).

Smith and Armitage (1931) point out that the Argentine ant is more aggressive when attending a small infestation of mealybugs than when attending a large infestation. The injurious effects of helotism thus tend to vary inversely with the size of the ant-attended population, the ant population being relatively static.

The introduction of the Argentine ant and its establishment in California and Africa had a noticeable effect on the biological control of certain pests of citrus. South Africa, the home of the black scale and its parasite *Metaphycus helvolus*, was invaded by the Argentine ant in 1902. Thereupon, the population of black scales increased very considerably, according to C. P. Lounsbury (Compere 1940). In preparation for shipping parasitized black scale to California, Lounsbury placed tanglefoot bands on heavily infested plants to prevent access of Argentine ants to the scales, and then after a lapse of several weeks, when parasites could oviposit without molestation, cut and shipped the heavily infested portions of the branches.

Compere (1940), during his exploration of Africa in 1936-37, found black scale abundant in two localities in the Union of South Africa and reported that it was "interesting and significant to note that the severe infestations were correlated with the presence of the Argentine ant, or an ant that appears similar and works just as effectively." In areas where the Argentine ant was not common, injurious infestations of black scale were not discovered, although scattered specimens were present almost everywhere. In November, 1936, Compere found hundreds of black scale infestations occurring throughout the gardens of Cape Town, in spite of the fact that the scales were heavily parasitized by *Coccophagus trifasciatus* Comp., *C. ochraceus* How., and *C. capensis* Comp.

Coccophagus trifasciatus, because of its abundance in ant-attended infestations of the black scale, had previously been considered a most desirable parasite for introduction into California; but after being successfully introduced and established, in 1924, it failed to live up to its reputation.

The relative ineffectiveness of *Metaphycus helvolus* in the presence of ants may account for the fact that in Africa it was rated as of little importance and its work was considered to be very "sporadic" (Smith and Compere 1926).

Prior to the introduction of *Metaphycus lounsburyi* and *M. helvolus* into California, Horton (1918) had observed that maximum black scale infestations occurred whether the Argentine ant was present or not. Since natural enemies, including *Coccophagus scutellaris* (Dal.), *Scutellista cyanea* Motsch., *Tomocera californica* How., and *Rhizobius ventralis* (Ehr.), had not proved capable of preventing severe infestations of this scale, the ant was of little practical importance.

Shortly after the introduction of the Argentine ant into southern California, in 1905, infestations of the citrus mealybug, *Pseudococcus citri* Risso, began to increase in severity and to spread more rapidly (Woglum 1919). The importance of this ant as a pest of citrus had been emphasized by Smith (1917).

As pointed out by Smith and Armitage (1931), the ants, when attending honey-producing species such as the citrus mealybug, often sense the presence of any insect, either parasite or predator, which is inimical to their interests. Their attack, however, is usually directed against the adult stages, particularly in the case of coccinellids (*Cryptolaemus, Hippodamia*, etc.), the larval stage being free from attack (Marsh 1910). The repelling effect of ants on parasitic Hymenoptera was noted by Ferton in 1890 (Wheeler 1910).

Other ant-affected enemies of citrus mealybug include the brown lacewings, *Sympherobius barberi* Banks and *S. californicus* Banks; the green lacewing. *Chrysopa californica* Coq.; the ladybird beetles *Hyperaspis lateralis* Muls., *Scymnus sordidus* Horn, *S. guttulatus* Lec., and *S. nebulosus* Lec.; and the dipterous predators *Leucopis bella* Loew. and *Diplosis* sp. These enemies are capable of keeping the citrus mealybug in check if not interfered with by the Argentine ant (Woglum 1919).

As a result of the mealybug increase following the introduction of the Argentine ant, the internal parasite *Leptomastidea abnormis* (Gir.) was introduced into California from Sicily in 1914. This parasite, however, is only occasionally a factor in reducing serious infestations of the citrus mealybug (Smith and Armitage 1931). According to Woglum (1942), the soft (brown) scale was seldom observed as a pest prior to the advent of the Argentine ant.

In order to avoid infestations of homopterous insects, fruit growers have at times banded their trees with ant barriers made of sticky substances. Experiments in central California (Bremner 1931) showed a remarkable reduction in

aphis on apple trees following the banding of the trees with tanglefoot. A citrus grower in southern California developed an ant barrier made of felt, which was manufactured for sale under the name "Insectolator." Klein (1939) reported that in an old grove of Valencia oranges in Beverley Hills, owned by Richard Dix, the portion that had been provided with Insectolators in July, 1938, had improved remarkably by the spring of 1939. Being free of ants, the foliage of the trees was healthy and abundant and the new fruit was better than commercially clean, although the old fruit that was still hanging on the trees was heavily infested with California red scale, *Aonidiella aurantii* (Mask.). Trees that were unprotected from the "hordes" of ants had thin, yellow foliage and little or no crop. Although the Argentine ant undoubtedly interferes with the activity of predators that attack the various stages of the red scale, an increase, if any, in severity of red scale infestation subsequent to the introduction of the ant in 1905 was unnoticed.

Incidentally, the effect of ants on red scale in China (the native home of citrus and of its pests the red scale and the red mite) was observed by J. L. Gressitt, Associate Professor of Entomology in Lingnan University at Canton. In correspondence in 1949 he informed the writer that he was fully convinced that the red scale is definitely related ecologically to the citrus red ant, *Oecophylla smaragdina* F. He stated that the red scale was rare except (1) where the red ant (and occasionally other species of ants) were present and (2) on very young seedlings where parasites had not yet become effective. Most of the red scale obtained from the larger trees was from or near the nests of the red ant. The citrus red ant is cultivated for the control of other citrus pests and in off seasons is fed with dead animals (Groff and Howard 1924).

Summary

The symbiotic relation between ants and certain homopterous pests of agriculture is occasionally an important factor in biological control work. The ant in the simple process of gathering honeydew tends to increase the growth rate of ant-attended populations of these pests and to decrease the population growth of ant-affected natural enemies. The activity of "nectar"-seeking ants aids man in his search for homopterous insects and their natural enemies. Such ants have been utilized in the bioassay of biological control. This use is limited, however, to certain species having effective natural enemies that are susceptible to interference by ants, and whose increase, when ant-attended, is not an effect of a higher growth rate and greater fecundity.

The fact that a certain natural enemy destroys an ant-created population of a pest is not an indication that this enemy is responsible for the over-all biological control of the pest species.

Literature Cited

Andrews, E. A. 1930. Honeydew reflexes. *Physiol. Zool.* 3: 467-484.

Barber, Ernest R. 1923. The sugar cane mealybug and its control in Louisiana. *Louisiana Agr. Expt. Sta. Bul.* 185: 1-16.

Bequaert, J. 1922. Ants in their diverse relation to the plant world. *Amer. Mus. Nat. Hist. Bul.* 45: 333-584.

Borden, Arthur D. 1923. Control of the common mealybug on citrus in California. *U.S. Dept. Agr. Farmers' Bul.* 1309: 1-10.

Bremner, O. H. 1931. Relation of ants to aphis control. *California Cult.* 77: 488-489.

Compere, Harold. 1940. Parasites of the black scale, *Saissetia oleae,* in Africa. *Hilgardia* 13: 387-425.

DeBach, Paul, C. A. Fleschner, and E. J. Dietrick. 1951. A biological check method for evaluating the effectiveness of entomophagous insects. (In preparation.)

Flanders, Stanley E. 1940. Environmental resistance to the establishment of parasitic Hymenoptera. *Ent. Soc. Amer. Ann.* 33: 245-253.

Flanders, Stanley E. 1942. Propagation of black scale on potato sprouts. *Jour. Econ. Ent.* 35: 687-689.

Flanders, Stanley E. 1943. The Argentine ant versus the parasites of the black scale. *California Citrog.* 28: 117-128, 137.

Flanders, Stanley E. 1945. Coincident infestations of *Aonidiella citrina* and *Coccus hesperidum*, a result of ant activity. *Jour. Econ. Ent.* 38: 711-712.

Flanders, Stanley E. 1950. Regulation of ovulation and egg disposal in the parasitic Hymenoptera. *Canad. Ent.* 82: 134-140.

Groff, G. W., and C. W. Howard. 1924. The cultured ant of South China. *Lingnan Agr. Rev.* 2: 108-114.

Heim, F. 1898. The biologic relations between plants and ants. *Smithsn. Inst. Ann. Rept.* 1896: 411-455. [Translation from: de la 24me Sess. de *l'Assoc. Franç. pour l'Avanc. des Sci. Compt. Rend.* 1895: (pt. 1) 31-75.]

Herzig, J. 1937. Ameisen und Blattlause (Ein Beitrag sur Okologie aphidophiler Ameisen). *Zeitschr. f. Angew. Ent.* 24: 367-435.

Horton, J. R. 1918. The Argentine ant in relation to citrus groves. *U.S. Dept. Agr. Bul.* 647: 1-72.

Huber, J. P. 1810. Recherches sur les moeurs des fourmis indigènes. Paris and Geneva—328 p.

Huber, J. P. 1820. The natural history of ants. (Trans. by J. R. Johnson.) London—389 p.

Jones, Charles R. 1929. Ants and their relation to aphids. *Colorado Agr. Expt. Sta. Bul.* 341: 1-96.

Klein, Jack. 1939. Ants and pest control. *California Cult.* 86: 423.

Kenyon, H. F. 1935. Spiders and ants. *California Cult.* 82: 224.

Marsh, H. O. 1910. Notes on a Colorado ant (*Formica cinereorufibarbis* Forel.) *U.S. Dept. Agr. Bur. Ent. Bul.* 64: 73-78.

Newell, Wilmon, and T. C. Barber. 1913. The Argentine ant. *U.S. Dept. Agr. Bur. Ent. Bul.* 122: 1-98.

Phillips, John S. 1934. The biology and distribution of ants in Hawaiian pineapple fields. *Hawaii Pineapple Prod. Sta. Bul.* 15: 1-57.

Smith, Harry S. 1917. The Argentine ant as an orchard pest. *California Citrog.* 2(10): 16-17.

Smith, Harry S., and H. M. Armitage. 1931. The biological control of mealybugs attacking citrus. *California Agr. Expt. Sta. Bul.* 509: 1-74.

Smith, Harry S., and Harold Compere. 1926. The establishment in California of *Coccophagus modestus* Silv. (Aphelinidae, Hymenoptera). *California Univ. Pubs. Ent.* 4: 51-61.

Smith, M. R. 1942. The relationship of ants and other organisms to certain scale insects on coffee in Puerto Rico. *Puerto Rico Univ. J. Agr.* 26: 21-27.

Tissot, A. N. 1939. Notes on the Lachnini of Florida with description of two new species (Homoptera: Aphiidae). *Florida Ent.* 22(3): 33-44.

Van der Goot, P. 1916. Veredere onderzoekingen omtrent de oeconomische beteekensis der gramang-mier. *Proefsta. Midden-Java, Salatiga, Meded.* No. 22. 120 p.

Woglum, R. S. 1919. How nature assists in mealybug control. *California Citrog.* 4: 106, 141. University Press, New York.

Woglum, R. S. 1942. The Argentine Ant. *California Citrog.* 27: 155.

Organization of a Scientific Paper[1]

By ROBERT GLEN[2]
Division of Entomology
Ottawa, Canada

Good organization of a scientific paper benefits both the writer and the reader. It enables the author to develop his subject systematically and logically, and to attain his objective with greater clarity, brevity, and emphasis. It provides the reader with a plan that he can follow and so keeps him attuned throughout to the writer's thought sequence. This contributes to comfortable reading and to better communication of information—worthy objectives in any type of writing. Lack of organization leads to confusion for both writer and reader.

Obviously, then, no writer can afford to neglect organization. A few scientists appear to achieve creditable results with a minimum of effort, but the great majority find it necessary to strive deliberately for good organization in their papers. The first step in approaching this problem is to see it clearly in relation to the whole subject of writing a scientific article. In general, the preparation of a paper may be divided into three stages: first, assembling and analysing the material; second, planning the discourse; and third, writing and revising. Processes of organization, as conceived in the present discussion, do not enter the first stage, but they dominate the second stage and the first part of the final stage. Therefore, problems of organization are the writer's chief concern from the time he first starts planning his discourse until he has completed the first or second written draft.

The principles of organization are discussed in the next three sections, first in relation to each other and to the paper as a whole, then in relation to procedure in planning, and lastly in relation to the actual writing. A final section is devoted to a few general remarks directed particularly to those who are beginning their careers as scientists.

Principles of Organization

Since sound organization is an essential feature of good writing, it is not surprising that the principles governing organization are those that have long been recognized as the fundamentals of English composition. Indeed, the same principles hold for the construction of individual paragraphs and individual sections as for the paper as a whole; and being *general principles*, they simply mark out the broad course of action, leaving plenty of scope for the individualities of writers. Of the five principles discussed below, unity and coherence distinctly outrank the others in importance.

Unity denotes oneness. It is the principle that governs the selection and the grouping of material. Proper application of unity ensures that the reader will be presented with but *one* thing at a time: one subject for the whole paper; one group of related topics in each section; one topic, composed of related thoughts, in each paragraph; and one thought, or two or three closely related thoughts, in each sentence (Anderson and Thistle, 1947).

Coherence governs arrangement and the interrelation of parts. The first component of coherence is proper sequence, which ensures that ideas and facts are presented in a systematic order. However, order itself is not enough; the reader must be made aware of that order. Hence continuity is also required. In scientific writing continuity is best obtained through the use of the deductive

[1]Contribution No. 2745, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada; presented as part of the symposium "Preparation of Scientific Papers" at the 86th Annual Meeting of the Entomological Society of Ontario, Winnipeg, Manitoba, November 4, 1949.
[2]Chief of Division; formerly Research Co-ordinator.

order of arrangement, which, broadly speaking, is the principle of proceeding from the general to the particular. For example, the introduction to the whole paper should give a preview of what is to come, and topic paragraphs and topic sentences should do the same for sections and paragraphs respectively. In this way the reader is spared the necessity of struggling with detail until he has been given a general plan to which the detail can be related. Other methods of arrangement that are commonly used are to proceed from the known to the unknown, from the simple to the complex, or from the near to the remote. However, some subjects have a fixed and inevitable order of sequence, such as the various steps in laboratory technique and the life-history stages of an insect. In these the principle of chronology governs. In striving for continuity, one should also consider phrases, sentences, or paragraphs, which orientate the reader by appropriate forward or backward references.

Proportion between parts demands attention. Important material should receive the more extensive treatment. As a consequence, the lengths of sections and paragraphs should bear some relation to the importance of their content.

Emphasis is a matter of contrast. It is related to proportion in that a measure of emphasis is secured simply by the degree of attention given to a topic. Emphasis, of course, is secured in many other ways: a single word or phrase may be italicized, a thought may be repeated, a single sentence may be raised to the status of a paragraph, or important material may be assigned the conspicuous position of the beginning or the end of the paragraph or section. The question of position reveals an inherent relationship between emphasis and sequence.

Climax is important in developing and holding interest and in achieving a proper finish to paragraphs, sections, and the whole discourse. The order of climax proceeds from the least important to the most important. Here again there is a relationship to the important principle of sequence.

The application of these principles to the preparation of a scientific paper is dealt with in the next two sections.

Planning the Paper

The purpose of planning is to bring order to the mass of material that is assembled during preliminary preparations. The first task is to determine what should be included and what excluded; the second, to classify the items retained; and the third, to prepare a working outline. The principles of unity and coherence are in command throughout the planning stage.

Selecting the Material

To answer the question "What is to be included in the paper?", the writer must first clarify his objective; he must have clearly in mind his purpose in writing the paper. Having done this, he then proceeds by application of the principle of unity to exclude all extraneous material, no matter how attractive it may be. Only material that is both on the subject and pertinent to the purpose of the discourse should be retained. The process of selection must receive serious attention as the first step in planning, and should be repeated periodically throughout the development of the article.

Failure to exclude extraneous material is an outstanding cause of weakness in scientific papers. For example, if a paper deals with the life-history of a given species, details of morphology are extraneous; if the paper is restricted to the subject of biology, there is no place for a discourse on control recommendations. The same principle holds in selecting material for each section and for each paragraph in the section.

Classifying the Material

After the material has passed the test of unity, its organization into a coherent whole is primarily a function of arrangement. In this the principles of sequence and continuity have full play.

It is recommended that the grouping and arranging of material be done as objectively as possible and without reference to any preconceived headings. By so doing, one procures the most natural order. However, the first step is to have something concrete to arrange. In the paragraph that follows a specific procedure is outlined.

Start your plan by noting each topic on a separate card or on a separate sheet of paper. Be sure to provide for all pertinent items, such as tables, graphs, keys, illustrations, and discussion of statistics. When this task has been completed, sort the cards into groups of related topics. These groups should form the sections or subsections of the paper. Then carefully arrange the cards for each section into a logical sequence, one that suggests the best means of developing the subject. If in this process certain items stand alone and appear as misfits, consider excluding them or remodelling the whole basis of classification.

Making the Outline

Having classified the material, the writer should commit his plan to paper. He must decide upon appropriate headings for each group of cards and he must decide which headings are co-ordinate and which are subordinate. His working outline then must take a physical form somewhat as follows:—

I. .....
  A. .....
    1. .....
      a. .....
        (1) .....
        (2) .....
      b. .....
    2. .....
  B. .....
II. .....

Note that co-ordinate items (I, II, III, etc., A, B, C, etc., 1, 2, 3, etc.) are in the same vertical plane. The headings for these should be grammatically parallel, for example:—

A. Morphology of the Head
B. Morphology of the Thorax
C. Morphology of the Abdomen.

The above skeleton outline gives five different orders of headings. However, in the actual preparation of text excessive subdivision should be avoided, for it tends to confuse rather than assist the reader. Three orders of headings usually suffice, these appearing in print as centre, side, and paragraph headings, respectively.

Scientific subjects are so varied that suitable headings for sections and subsections must follow the nature of the material presented rather than any formal pattern. However, each heading should be reduced to the key words appropriate to the content. In all cases provision should be made for an introductory section and for a terminating summary statement. Anderson and Thistle (1947) suggest the following basic plans:—

Introduction	Introduction
Materials	Topic I
Methods	Topic II
Results	Topic III
Discussion	Discussion
Acknowledgments	Acknowledgments
References	References

The left-hand plan is suitable for single investigations made throughout with the same materials and methods. The right-hand plan is suitable for a wide variety of descriptive papers, or for papers on a group of related studies, each made with different materials and methods. These two plans may be combined and modified in various ways to meet special needs. For example, materials and methods may be combined into a single section; likewise results and discussion may be treated to advantage under a common heading.

As a final step, the writer should prepare introductory paragraphs for each section and subsection and topic sentences for each of the paragraphs within sections. The preparation of the paper is now passing from the planning to the writing stage.

Writing the Paper

With a carefully thought-out plan in hand, the task of writing the paper is not formidable. The first objective should be to prepare a complete draft of each section as speedily as possible. As Anderson and Thistle (1947, p. 10) say, "Write the first draft rapidly without bothering about details like punctuation, spelling, or finding the best word—leave a blank if necessary. Give the creative faculties full play, and give the critical faculties a rest; they will be needed later." It is important, however, to follow carefully the outline already prepared as a guide. In the preparation of the first draft and in the revisions that follow, the principles of unity and coherence still find application, but those of proportion, emphasis, and climax come into prominence for the first time.

The Title

If a title has not already been chosen, one should be drafted now. Use as few words as possible to convey the content of the paper, having in mind the value of the title for catching the interest of the reader and later for purposes of indexing. Preference should be given to descriptive words that achieve both brevity and comprehensiveness.

The Introduction

The introduction should state clearly the general scope of the paper and the purpose of the studies described, and give the orientation and setting of the investigation under discussion. Reference may appropriately be made to important works in the literature, but a lengthy review, if necessary, should be reserved for a separate section.

Some writers prefer to write the introduction last. However, early preparation of this section forces the author to consider his paper as a whole, before proceeding to a discussion of its parts. This is desirable, and it is recommended that a draft introductory section be prepared at the beginning of the writing and that it be reviewed and revised several times before a final draft is made. This first section warrants such special attention because its content, arrangement, and style may well determine whether the reader will proceed further with his perusal of the article.

Other Main Sections

The content of each major section in the body of the paper will be determined largely by the topics on the cards and by the topic sentences for para-

graphs. However, the principle of proportion comes into play in determining how much space and attention are warranted for any specific item. For example, in dealing with methods, the writer should be conscious of the fact that the validity of his research has its foundation in the method he has used. He should not skimp this section. In his description of experiments and results the writer must strive to be both comprehensive and concise, summarizing his data in the most effective form, omitting unimportant experiments and results and the details of replications, and using a logical order of presentation rather than the sequence in which the experiments have been performed. In his discussions and conclusions he must take care to differentiate clearly between fact, hypothesis, and theory; and between inference, opinion, and judgment. Scientific ethics, if nothing else, demands accuracy in every statement that is recorded in the literature.

Having settled these details of content, the writer should review again his plan of sequence and determine whether revision would achieve increased emphasis or better climax.

Once the subject matter has been carefully apportioned to different topics, writing is largely a matter of paragraph development. On this subject Allbutt (1925, p. 72) states, " A paragraph, unless it be in a summary or emphatic position, is more than a sentence; it is a group of sentences, one bearing on another, and thus compassing a wider meaning than the sentence; it has accordingly its own subject and unity, though of much narrower scope than the chapter [or section]." The subject of the paragraph, for purposes of scientific writing, is best conveyed in the first sentence—the topic sentence. The advantages of this system are outlined by Riker (1946, p. 968) as follows: "The chief advantage of writing so that the topic is clearly stated in the first sentence . . . is that the reader can glance rapidly over the article; he can locate easily the paragraphs in which he is interested: he can skip everything else. And this is, after all, a critical test for good writing in a technical paper." This discussion is carried further in an excellent paragraph from Anderson and Thistle (1947, p. 13): "Readers most frequently lose their way between paragraphs. And this often happens merely because the first sentence is poorly phrased; so topic sentences, besides introducing new subjects, have the important function of providing articulation. When skilfully worded, with appropriate forward or backward references, these transitional sentences are invaluable for showing the relations between parts of the presentation. Danger points occur especially when the train of thought is broken; the topic sentence must then give the reader an unmistakable warning. Too often he reads a paragraph about Table I and is halfway through the next paragraph before he realizes that the author is no longer discussing Table I but Table II. Nor can the need for careful articulation between paragraphs be overlooked when the change in topic is less abrupt; a joining word or phrase may still be required. The reader must be kept continuously oriented within the unknown country of the author's mind; transitional paragraphs and sentences are the landmarks and roadsigns by which the reader finds his way."

The Summary

A formal summary or a final summarizing paragraph is expected in most scientific articles. Essential elements in such a statement are the scope of the work and the principal findings. In telling what was found, a skilful author can usually imply what was done; this is better than including purely descriptive matter.

Revision

Style and phrasing are the writer's chief concern during revision, but the wise author will also check on details of organization. In checking these it will prove helpful to ask two questions before revising the first written draft: (a) Is the reader kept informed of the plan being followed and of how it is being developed? The answer should be found, first of all, in the various introductory statements—the introduction to the whole paper, the topic paragraph in each section, and the topic sentence in each paragraph; next, in the transitional passages that link the topics and reveal interrelationships; and finally in the section headings and subheadings, which should serve as suitable signposts marking the way. (b) "Does the writing show fitting climax, due emphasis, proper proportion, unity, and logical sequence? If any one of the first three qualities is lacking, a certain amount of patching, rearranging, and rephrasing will be required. If either of the last two qualities is lacking, nothing will serve but a drastic reorganization." (Anderson and Thistle, 1947, pp. 12-13).

Thoughts for Beginners

The organization of a scientific paper is an integral part of the larger subject of the complete preparation of a scientific paper, which in turn is part of the still larger entity, the research project. The final section of this discourse is devoted, therefore, to brief remarks relating the subject of this paper to the larger issues with which it is connected. These remarks deal mainly with points of view and attitudes and therefore are of particular concern to young scientists who are beginning their careers and who have not yet fully determined their approach to problems in their chosen field.

Recognize Writing as Part of Research

It is all too common a weakness among workers in applied science to regard the writing of publications as something apart from their normal activities as investigators. Actually, every research project should be recognized as a unit, a unit of endeavour that begins with a hypothesis and ends with a publication. Between the beginning and the end there is no proper stopping place. The training for research that one receives in most graduate schools and in many research institutions frequently neglects this principle. As a result, the young research officer is improperly prepared for the task that awaits him. This, however, does not alter the facts that he needs training in scientific writing just as much as he needs training in research methods, and that it is his own responsibility to fit himself for his life's work. The first step is to recognize that writing is part of research.

Develop a Concept of a Scientific Paper

Research specialists find it necessary to develop concepts and other working hypotheses. For example, a specialist in insect taxonomy recognizes the importance of developing his own species concept before feeling that he is ready to conduct effective research. Similarly, the competent field investigator studies biometry and field plot techniques in order to master the principles that underly such types of investigation. However, scientists rarely study the principles of writing. But there is just as much need for a good working concept of a scientific paper as for any other concept in research. How can this be achieved?

First, study seriously the subject of scientific writing. Several excellent articles on the question have appeared in recent years. Reference has already been made to Allbutt (1925), Riker (1946), and Anderson and Thistle (1947). These are all good; but the beginner will find most of his requirements in the last-named alone. Other splendid contributions include those by Harris (1945),

Anderson (1945a, 1945b), and Jones (1946). Perrin (1942) is a good standard reference to English composition in general. The subject should be studied systematically with emphasis upon the underlying principles; then the scientific literature should be examined for examples of good and poor application of these principles, and the student should assess the effect of each type upon him as a reader.

Secondly, practice writing. The principles of organization and phrasing should be applied earnestly in every report written, whether it be a simple progress statement or a detailed, technical account. Practice might even be carried further through taking a short report or a section of a longer one, making an all-out effort to organize it thoroughly and to express the message concisely and clearly, and then having it scrutinized by a competent critic.

By these means the concept of a scientific paper will gradually be developed. Thereafter, the writing of a technical article can be approached with confidence and not with the reticence that characterizes so many research officers today.

Aim at a Standard in Writing

A large proportion of scientific papers are prepared for presentation at professional meetings. This inevitably means that these papers have to be completed by a specified date. Undoubtedly this procedure serves as a spur to the writer and drives him on to accomplish much in a relatively short time; but it also exposes him to the danger of developing an undesirable attitude toward the task of writing papers. The young scientist is advised to aim at a standard and not at a deadline.

Begin to Publish Early

Publication should be undertaken early in one's career. Even if the first paper or two be little more than research notes, the experience gained from their preparation will be well worth while. Further, in addition to the advantages of having one's achievements recorded in print, there are those of training oneself to keep the thought of publication to the forefront when planning work, of forming the habit of publishing significant information as soon as it is obtained, of developing the skills prerequisite to the preparation of longer and more comprehensive articles, and of avoiding the frustration and lack of confidence that so frequently overtake the worker who puts off the final act of writing up his results. Doing these things from the beginning facilitates the development of procedures and attitudes that will bear dividends throughout one's active life.

Never Forget the Reader

Dr. Rudolph Flesch, of the Readability Laboratory, Columbia University, New York, has developed an interesting scale of reading difficulty (Procedures and Records Committee . . . Commission, 1946, p. 6). In the most difficult class of reading he includes the material of scientific and professional journals. This material he characterizes as "comfortable reading for no one". Scientists should keep in mind, therefore, that even when well done their papers are hard enough to read. The only realistic approach to this problem lies in a willingness to give the extra effort required to make scientific writing as readable as possible. Never forget the reader!

However, if the subject is studied diligently and the preparation of each paper is approached systematically and with determination, success will invariably follow.

References

Allbutt, Sir Clifford. 1925. Notes on the composition of scientific papers. Macmillan and Co. Limited, London.

Anderson, J. A. 1945a. The role of statistics in technical papers. *Trans. American Assoc. Cereal Chem.* 3: 69-73.
Anderson, J. A. 1945b. The preparation of illustrations and tables. *Trans. American Assoc. Cereal Chem.* 3: 74-104.
Anderson, J. A., and M. W. Thistle. 1947. On writing scientific papers. *Bull. Canadian J. Res.* No. 1691. National Research Council of Canada.
Harris, H. L. 1945. Shortcuts to unity, clearness, and brevity. *Trans. American Assoc. Cereal Chem.* 3: 60-68.
Jones, W. Paul. 1946. Writing scientific papers and reports. Wm. C. Brown Co., Dubuque, Iowa.
Perrin, P. G. 1942. Writer's guide and index to English. Scott, Foresman and Company, Chicago, Ill.
Procedures and Records Committee, Council of Personnel Administration, United States Civil Service Commission. 1946. How does your writing read? United States Government Printing Office, Washington, 25, D.C.
Riker, A. J. 1946. The preparation of manuscripts for *Phytopathology*. *Phytopathology* 36: 953-977.

A Description of the Previously Unknown Male of *Cyrtolobus griseus* Van Duzee

By Clifford J. Dennis
University of Wisconsin

Apparently, the male of *Cyrtolobus griseus* Van Duzee (Stud. N.A. Memb. 90.16, 1908) has never been described. The following is a description of a male which is here designated the allotype. This specimen was collected in the University of Wisconsin Arboretum, Madison, July 21, 1950 from bur oak (*Quercus macrocarpa* Michx.). The allotype is in the author's collection.

***Cyrtolobus griseus* Van Duzee, male allotype**

Resembling the males of *C. vau* (Say) and *C. pulchellus* Woodruff; but differs from *vau* in having the anterior arm of the dark "V" of the pronotum narrowed at the middle and by being generally lower; it differs from *pulchellus* by being larger.

Pronotum with metopidium with dark brown suprahumeral bands and carina, mottled with chocolate brown between the suprahumeral bands; margin of pronotum broadly white over humeral angles; anterior oblique and anteapical vittae and mid-dorsal spot distinct, white; a prominent dark brown "V" formed between the vittae and mid-dorsal spot has its anterior arm narrowed at the middle; tip of pronotum dark brown.

Face white, punctate with dark brown; ocelli red.

Elytra hyaline; clavus and base of corium with dark punctures; veins prominent, dark brown, punctate along margins; apical cloud small, dark brown, occupying the terminal cell and posterior ¼ of cell above it.

Undersurface: head white with a patch of dark brown below the eyes, thorax black, abdomen pale with some blackening at edges and in centre of segments.

Legs with coxae pale medially, black laterally; femora flavous; tibiae and tarsi fuscous.

Overall length 6.2 mm, width 2.8 mm.

Other specimens examined show variations in amount of mottling and width of suprahumeral bands on the metropidium. Their lengths vary from 5.9-6.3 mm and their widths from 2.7-2.9 mm.

In the author's study of the genitalia of the Wisconsin species of *Cyrtolobus* and allied genera no constant diagnostic characters were found. For this reason no genitalia description is included.

Outbreak of a Springtail, *Achorutes nivicolus* Fitch, at Ottawa

An interesting record of a severe infestation of this insect in the early spring of 1950 was obtained from a farm at Leitrim, Ontario, five miles southeast of Ottawa. The writer, on visiting the farm on March 28, found that the snow in the front- and back-yards of the house was grey with the insect. The springtails were on the side of the house, on the verandah, and on the doorstep; and the owner of the house claimed that they were everywhere inside, even in the beds. He alleged also that the infestation extended over 25 to 30 acres of his farm, and that he had first noticed the insect on March 25.

H. G. James of the Dominion Parasite Laboratory, Belleville, Ontario, who identified the specimens, states (in litt.), "When the Iroquois spoke of 'soft weather fleas' during the winter this was probably the insect they had in mind. Although a number of species of Collembola are found on snow, *A. nivicolus* is usually the one that occurs in outbreak numbers. Charles Macnamara gives an interesting discussion of *A. nivicolus* Fitch [= *A. socialis* Uzel] in *Canadian Ent.* 54: 149. This species is common in many parts of Europe as well as in North America, and according to Harlow B. Mills (1934. The Collembola of Iowa. Collegiate Press, Ames, Iowa) it is cosmopolitan."

L. M. Cass
Vegetable Insect Laboratory
Division of Entomology
Ottawa, Canada

The Illustration of Entomological Papers

Readers will have noted that, beginning with the January number, a better grade of paper has been adopted for the *Canadian Entomologist*. This step was taken in order to meet the demand for a better reproduction of photographic illustrations, in which a good deal of important detail was lost with the paper formerly used. It will we think be generally agreed that the new paper is a great improvement.

However, we should like to take this opportunity of making some general observations on the illustration of entomological papers.

When a new technique is discovered, and particularly if it appears to save work, there is naturally a general tendency to adopt it and to discard the older methods. For example, after the microtome came into general use, many morphologists gave up dissection and began to use the method of building wax or paper models from sections. This method is theoretically attractive but in practice very laborious. Furthermore, for various reasons the results obtained from it are not always accurate. A morphologist who takes the trouble to acquire reasonable skill in dissection will often find that he can work out anatomy much more rapidly than by section-cutting.

We hope we shall not be regarded as reactionary if we say that the pictorial representation of natural objects, though immensely older than written descriptions as such relics as the Grotto of Altamira bear witness, is, in many cases, more effective and valuable; and that some of the older pictorial representations were much more useful than those made with later methods.

To begin with, an accurate pictorial representation of an insect is better than a description; particularly for the systematist. This is because an accurate pictorial representation gives simultaneously, all the forms, dimensions and quantitative relations between anatomical parts whereas the written description includes only a selection of these features, deemed at the time to be of systematic

importance. But as systematic work becomes more extensive and penetrating, it is found that certain neglected characters, among which are the dimensional relations of certain structures, have great taxonomic significance. This is why it is often difficult or impossible to identify the species described by Linnaeus and Meigen. On the other hand the preparation of descriptions sufficiently complete to give not only what we now know to be useful, but everything that might conceivably be useful, is a practical impossibility. Good illustrations are therefore better than good descriptions.

When a knowledge of the colour of an insect and its parts is necessary for identification, a coloured illustration is of course better than a black and white illustration, even accompanied by a description. Colour is a quality and we cannot in practice, reduce it to something mensurable. All we can do is to identify it with a particular specimen in a book of colours. It is obviously simpler and better to reproduce the colour in the illustration.

Furthermore, a good drawing is better than a good photograph. In the early days of photography amateurs presented their unfortunate relations with terrible caricatures, assuring them that the camera cannot lie. We know better now. In fact it is far more difficult to get an accurate photograph of a whole insect or of a complex organ requiring high magnification, than to get an accurate drawing. It may be replied that the artist sometimes eliminates important details. But the camera also does this and in addition it includes details that are confusing and entirely irrelevant.

Entomological articles in the field of morphology and systematics should therefore be accompanied by good drawings. If colour is of diagnostic importance, the drawings should be in colour.

The reproduction of drawings must also be considered. Nowadays the artist is usually obliged to make drawings that can be reproduced by the cheapest methods, for example, the zinc cut. This imposes on the artist a much too severe restriction on the use of the materials at his disposal and often prevents him from selecting those best adapted to his task. We shall not attempt in this short note to explore this complex subject in detail; but we must say that in our opinion nothing surpasses the results obtained from the really first-class lithographers. Admittedly, the process is expensive; but we feel sure that in the long run it pays. The preparation of illustrations for lithographic reproduction greatly facilitates the work of the entomological artist and the beauty of good lithographic plates is unsurpassed. This is very good for the morale of morphological and systematic workers.

We therefore venture to suggest to the authorities responsible for the illustrations of scientific papers the desirability of providing good artists to illustrate entomological publications, of giving them freedom to adopt the methods best suited to the material and of ensuring that the finest methods of reproduction are adopted. Few reforms would do more to stimulate work in the field of morphology and systematics which are, after all the basis of applied entomology.

W. R. Thompson

The Runge Press Limited, Ottawa
Mailed: Monday, April 30, 1951